

6.6 LARGE-SCALE POWER PLANTS

6.6.1 Introduction

The Department regulates power plants that produce or are designed to produce more than 25 megawatts of electricity. The electric power industry uses cooling towers to dissipate excess heat that builds up in the electrical generation process. Evaporation losses in the cooling towers at power plants are the major consumptive use of water at these facilities. Because of the large volume of water used in this capacity, conservation requirements for the electric power industry require facilities to achieve a high level of efficiency in cooling tower operations.

6.6.2 Water Use by Large-Scale Power Plants

Although there are currently no large-scale power plants in the Pinal AMA, it is anticipated that one will be constructed in Casa Grande in the near future. The proposed facility will be powered by natural gas and produce up to 500 megawatts of electricity. The facility's annual water demand is expected to be nearly 4,000 acre-feet. Initially, most of this demand is expected to be met through the use of municipal CAP water allocated to the Arizona Water Company's Casa Grande system. Effluent from the City of Casa Grande's wastewater treatment plant will also be used. As the city grows and the supply of effluent increases, it is anticipated that more effluent and less CAP water will be used.

Most electric power plants have two water use circuits, referred to here as the generating circuit and cooling circuit. In the generating circuit, water is heated in the boiler to form steam that turns the turbines. The turbines in turn drive the generators that create electricity. The steam must be cooled and condensed into water before being recycled back to the boiler. The conversion of water to steam and back to water in the generating circuit is completed in a closed system, so water is efficiently recycled with little loss.

At the condenser, heat is transferred from the steam in the generating circuit to the cooled water in the cooling circuit. Because this heat exchange occurs through the walls of the condenser piping, water in the two circuits does not mix. The heated water in the cooling circuit is pumped to a cooling tower where it is cooled by evaporation. The cooled water is then recirculated back to the condenser. Evaporation losses in the cooling tower constitute the main consumptive use of water at electric power plants. As a portion of the cooling circuit water evaporates in the cooling tower, dissolved minerals become more concentrated in the remaining water. Due to the high mineral concentrations, corrosion, mineral deposition, and biological fouling can result and may lead to reduced cooling efficiency and equipment damage. Use of chemical treatments can prolong water use in a tower; but periodically, mineral-laden water must be discharged or "blown down" to prevent minerals from precipitating on equipment. Replacement water, known as "make-up water," is added to replace water lost to evaporation and blowdown.

The "cycles of concentration" or "concentration ratio" achieved in a tower indicate how efficiently water is being used. Cooling towers that are consistently operated at higher cycles of concentration consume less water than towers consistently operated at lower cycles of concentration. Cycles of concentration can be determined by dividing the concentration of a constituent in the blowdown water by the concentration of this same constituent in the make-up water. Total dissolved solids content is one commonly used constituent for calculating the cycles of concentration.

6.6.3 Large-Scale Power Plant Program

The Third Management Plan requires that large-scale power plants achieve an annual average of 15 cycles of concentration in their cooling towers. The cycles of concentration requirement applies only during periods when facilities are generating electricity and applies only to fully operational towers that are dissipating heat from the power generation process. In addition to achieving 15 cycles of concentration,

facilities must discharge blowdown water and add make-up water to cooling towers on a continuous basis and divert the maximum possible volume of onsite wastewater (other than blowdown water and sanitary wastewater) to the cooling process.

Facilities may be granted adjustments to their full cycles of concentration requirements in cases where, due to the quality of recirculating water, adhering to the 15 cycles of concentration standard is likely to result in equipment damage or blowdown water exceeding environmental discharge standards. Cooling towers at power plants are exempted from cycles of concentration requirements during the first 12 months in which treated effluent constitutes more than 50 percent of tower water supply. After this period, facilities may request an adjustment to full cycles of concentration requirements for effluent-served towers based on the water quality of the treated effluent supply.

Facilities may apply to the director to use alternative conservation technologies in place of achieving 15 cycles of concentration if the use of the proposed alternative technologies will result in equal or greater water savings. Facilities may also request a waiver from conservation requirements on the basis that cooling tower blowdown water is completely reused. Facilities must periodically measure and annually report blowdown water volumes, make-up water volumes, and the chemical concentration of blowdown and make-up water. In addition, facilities must report the amount of electricity generated, periods when they are not generating electricity, and the volume of water used for purposes other than electric power generation.

6.6.4 Future Directions

As previously mentioned, there are currently no large-scale power plants in the Pinal AMA. The facility that is currently being planned for the Casa Grande area is expected to utilize 100 percent renewable supplies.

6.6.5 Industrial Conservation Requirements and Monitoring and Reporting Requirements for Large-Scale Power Plants

6-601. *Definitions*

In addition to the definitions set forth in Chapters 1 and 2 of Title 45 of the Arizona Revised Statutes, unless the context otherwise requires, the following words and phrases shall have the following meanings:

1. *“Blowdown water” means water discharged from a cooling tower recirculating water stream to control the buildup of minerals or other impurities in the recirculating water.*
2. *“Conservative mineral constituent” means a component of recirculating water in a cooling tower, the concentration of which is not significantly modified by precipitation, loss to the atmosphere, or the addition of treatment chemicals.*
3. *“Continuous blowdown and make-up” means patterns in cooling tower operation which include continuous blowdown and make-up or frequent periodic blowdown and make-up of recirculating water.*
4. *“Cycles of concentration” means the ratio of the concentration of total dissolved solids, other conservative mineral constituent, or electrical conductivity in the blowdown water to the concentration of this same constituent or electrical conductivity in the make-up water.*
5. *“Effluent-served cooling tower” means a cooling tower served by a make-up water supply which on an annual average basis consists of 50 percent or more effluent.*
6. *“Fully operational cooling tower” means a cooling tower that is functioning to dissipate heat from a large-scale power plant that is generating electricity.*
7. *“Large-scale power plant” means an industrial facility that produces or is designed to produce more than 25 megawatts of electricity.*
8. *“Limiting Constituent” means a chemical, physical, or biological constituent present in recirculating cooling tower water which, due to potential physical or biological factors or due to potential exceedence of any federal, state, or local environmental standards upon discharge as blowdown, should not be allowed to accumulate in recirculating cooling tower water above a certain concentration.*
9. *“Make-up water” means the water added back into the cooling tower recirculating water stream to replace water lost to evaporation, blowdown, or other mechanisms of water loss.*

6-602. *Conservation Requirements for Large-Scale Power Plants*

Beginning on January 1, 2002 or upon commencement of water use, whichever occurs later, and continuing thereafter until the first compliance date for any substitute conservation requirement in the Fourth Management Plan, an industrial user who uses water at a post-1984 power plant shall comply with the following requirements:

1. *An annual average of 15 or more cycles of concentration shall be achieved at fully operational cooling towers during periods when the power plant is generating electricity.*
2. *Blowdown water shall be discharged on a continuous basis, and make-up water shall be provided on a continuous basis.*
3. *The maximum amount of wastewater feasible, excluding blowdown water and sanitary wastewater, shall be diverted to the cooling process.*

6-603. Cycles of Concentration Adjustment Due to the Quality of Recirculating Water

- A. An industrial user who uses water at a large-scale power plant may apply to the director for an adjustment to the cycles of concentration requirements set forth in section 6-602 if compliance with the cycles of concentration requirements would likely result in damage to cooling towers or associated equipment or exceedence of federal, state, or local environmental discharge standards because of the quality of recirculating water. To apply for an adjustment to the cycles of concentration requirements based on recirculating water quality, an industrial user shall submit a request in writing to the director which includes the following information:*
 1. *Historic, current, and projected water quality data for the relevant constituent(s).*
 2. *Documentation describing the potential damage to cooling towers or associated equipment or documentation of environmental standards that are likely to be exceeded, whichever applies.*
- B. The director shall grant the request if the director determines that compliance with the cycles of concentration requirements set forth in section 6-602 would likely result in damage to cooling towers or associated equipment or exceedence of federal, state, or local environmental discharge standards because of the quality of recirculating water.*

6-604. Exemption and Cycles of Concentration Adjustment Due to the Quality of Effluent Make-up Water Supplies

- A. The cycles of concentration requirements set forth in section 6-602 do not apply to any effluent-served cooling tower at a large-scale power plant during the first 12 consecutive months in which more than 50 percent of the water supplied to the cooling tower is effluent.*
- B. After the 12-month exemption period expires, the industrial user who uses water at the large-scale power plant may apply to the director for a cycles of concentration adjustment to lower the cycles of concentration requirement for the effluent-served cooling tower if compliance with the requirement would not be possible due to the presence of a limiting constituent in the effluent that supplies the tower. To apply for an alternative cycles of concentration requirement to address such a limiting constituent, an industrial user shall submit a request in writing to the director which includes the following information:*
 1. *The limiting constituent that is present in the effluent supplying the tower which results in the need to blow down a greater annual volume of water than that required in section 6-602.*
 2. *Documentation describing the concentration at which this limiting constituent should be blown down, and the reason for the alternative blowdown level.*

The director shall grant the request if the director determines that the presence of a limiting constituent in the effluent that supplies the cooling tower results in the need to blow down a greater annual volume of water than that required in section 6-602. Any cycles of concentration adjustment granted pursuant to this paragraph shall apply only while the tower qualifies as an effluent-served cooling tower.

6-605. *Alternative Conservation Program*

An industrial user who uses water at a large-scale power plant may apply to the director to use conservation technologies other than those prescribed in section 6-602. The director shall approve the use of alternative conservation technologies if both of the following apply:

- 1. The industrial user files with the director a detailed description of the proposed alternative technologies and the water savings that can be achieved by the use of the alternative technologies.*
- 2. The director determines that the alternative conservation technologies will result in water savings equal to or greater than the savings that would be achieved by the applicable conservation technologies prescribed in section 6-602.*

6-606. *Waiver*

- A. An industrial user who uses water at a large-scale power plant may apply to the director for a waiver of any applicable conservation requirement in section 6-602 by submitting a detailed, long-term plan for beneficial reuse of 100 percent of blowdown water outside the cooling circuit, including an implementation schedule. Reuse of blowdown water includes the discharge of blowdown water into pipes, canals, or other means of conveyance if the discharged water is transported to another location at the plant or off the plant for reuse.*
- B. The director shall grant a waiver request if the director determines that implementation of the plan will result in the beneficial reuse of 100 percent of blowdown water outside the cooling circuit. If a waiver request is granted, the industrial user shall implement the plan in accordance with the implementation schedule submitted to and approved by the director.*

6-607. *Monitoring and Reporting Requirements*

- A. For calendar year 2002 or the calendar year in which water use first commences, whichever is later, and for each calendar year thereafter until the first compliance date for any substitute requirement in the Fourth Management Plan, an industrial user who uses water at a large-scale power plant shall include in its annual report required by A.R.S. § 45-632 the following information:*
 - 1. Cooling capacity in tons of each cooling tower at the facility.*
 - 2. Frequency of use of each cooling tower at the facility.*
 - 3. Source of water providing make-up water to each cooling tower at the facility.*
 - 4. For each cooling tower at the facility that is exempt from cycles of concentration requirements pursuant to section 6-604, subsection A, or for which a cycles of concentration adjustment was granted pursuant to section 6-604, subsection B, the percentage of water served to the tower during the year that was effluent.*

5. *For all fully operational cooling towers subject to cycles of concentration requirements under section 6-602:*
 - a. *The total quantity of blowdown water discharged from the cooling towers for each month or partial month when the facility was generating electricity during the calendar year.*
 - b. *The total quantity of make-up water used at cooling towers for each month or partial month when the facility was generating electricity during the calendar year.*
 - c. *The weighted average concentration of total dissolved solids or other conservative mineral constituent in make-up water and blowdown water at the cooling towers for each month or partial month when the facility was generating electricity during the calendar year, either:*
 - 1) *Determined by direct analysis, or*
 - 2) *Calculated based on average monthly electrical conductivity readings if the following conditions have been met: (a) correlations between electrical conductivity and total dissolved solids or between electrical conductivity and another conservative mineral constituent have been established over a period of one year or more in make-up and blowdown water and (b) documentation of these correlation has been provided to the director.*
6. *For each fully operational cooling tower that is exempt from cycles of concentration requirements pursuant to section 6-604, subsection A, or for which an adjusted cycles of concentration requirement was granted pursuant to section 6-603 or section 6-604, subsection B:*
 - a. *The total quantity of blowdown water discharged from the cooling tower for each month or partial month when the facility was generating electricity during the calendar year.*
 - b. *The total quantity of make-up water used at the cooling tower for each month or partial month when the facility was generating electricity during the calendar year.*
 - c. *The weighted average concentration of total dissolved solids or other conservative mineral constituent in make-up water and blowdown water at the cooling tower for each month or partial month when the facility was generating electricity during the calendar year, either:*
 - 1) *Determined by direct analysis, or*
 - 2) *Calculated based on average monthly electrical conductivity readings if the following conditions have been met: (a) correlations between electrical conductivity and total dissolved solids or between electrical conductivity and another conservative mineral constituent have been established over a period of one year or more in make-up and blowdown water and (b) documentation of these correlation has been provided to the director.*
7. *All time periods when the facility was not generating electricity.*

8. *The amount of electricity generated each month or each partial month when the facility was generating electricity during the calendar year.*
 9. *The estimated quantity of water from any source, including effluent, used during the calendar year for each purpose other than electric power generation purposes.*
- B.** *A single annual report shall be filed for power plants that are contiguous and owned by the same owner. The report shall describe the combined operations of the power plants as required in subsection A of this section.*
- C.** *All water measurements required in this section shall be made with a measuring device in accordance with the Department's measuring device rules, A.A.C. R12-15-901, et seq.*